United States Patent [19]

Sauer et al.

[11] **3,783,859**

[45] **Jan. 8, 1974**

[54] **NOVEL EXTERNAL CIRCULATORY ASSIST DEVICE**

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[52] **U.S. Cl.** ..... **128/24 R**, 128/64

[51] **Int. Cl.** **A61h 1/00**

[58] **Field of Search** ..... 128/24 R, 64, 25 R, 128/60, 25 B

[56] **References Cited**

UNITED STATES PATENTS

3,303,841	2/1967	Dennis	128/24 R
3,403,673	10/1968	MacLeod	128/64 UX
3,654,919	4/1972	Birtwell	128/64

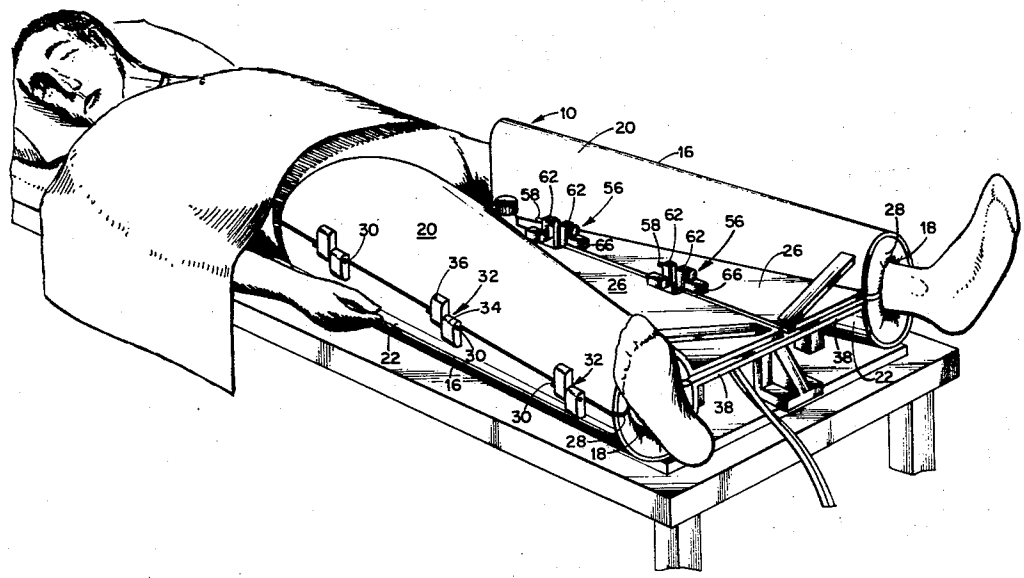
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[57] **ABSTRACT**

Novel external pressure circulatory assist apparatus utilizing movement of a shell portion of a limb-enclosing housing as a mechanical means for applying the requisite cyclic pressure to the limbs of a patient being treated.

6 Claims, 4 Drawing Figures



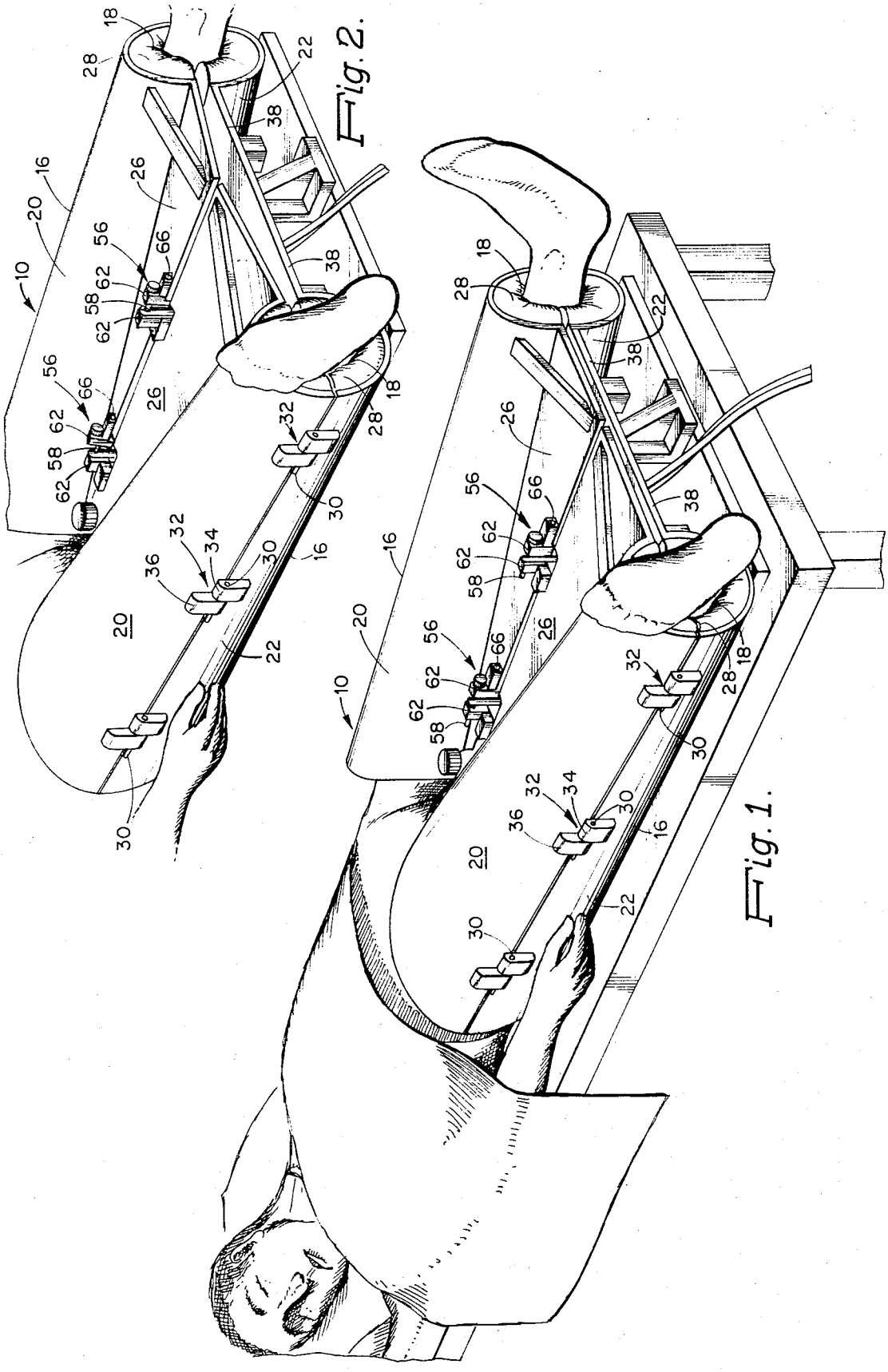

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16
18
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36
38
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58
62
66

Fig. 1.

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62
66

Fig. 2.

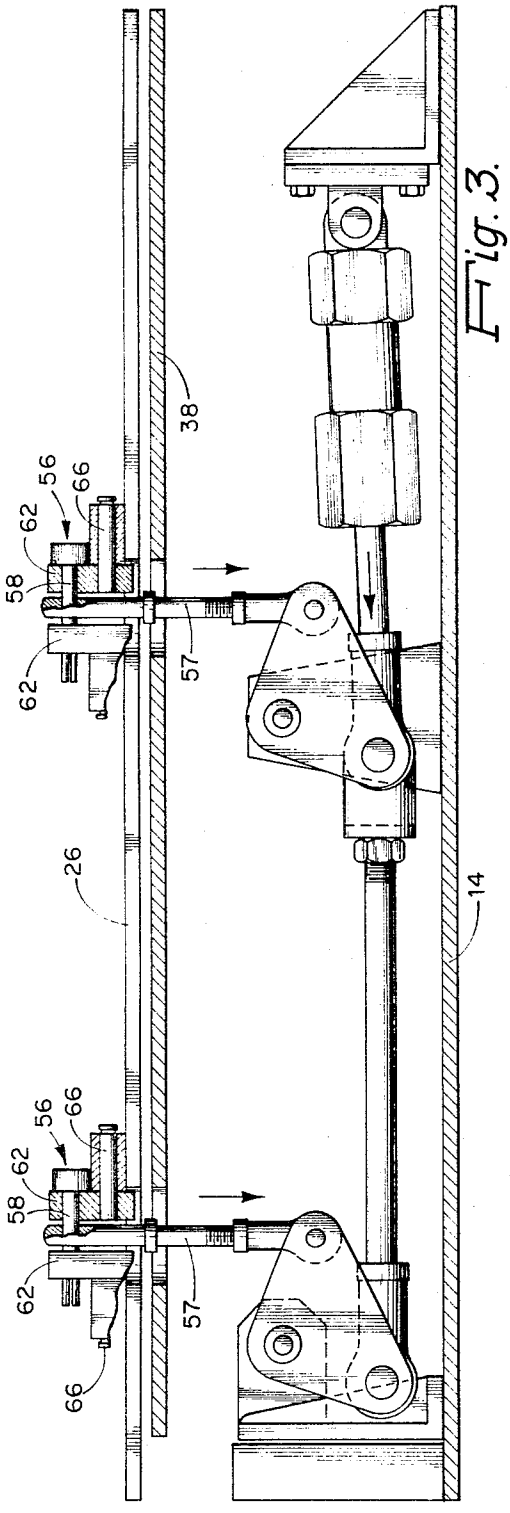

38
56
66
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62
57
26
14
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62
57
66

Fig. 3.

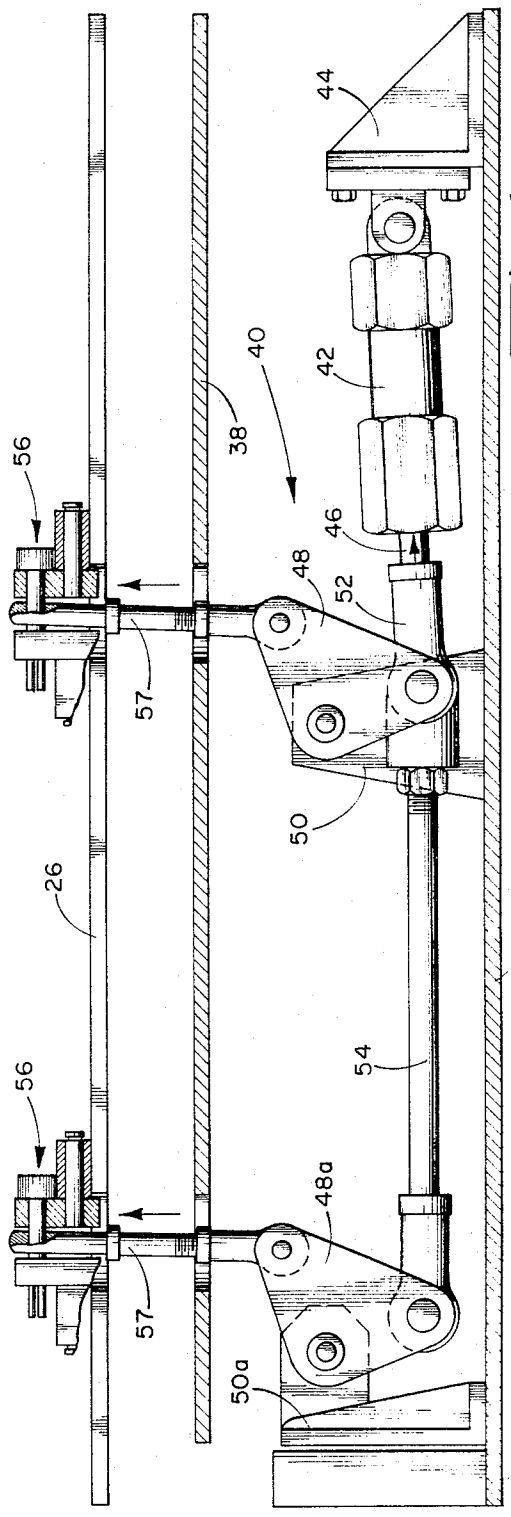

44
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42
38
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46
48
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57
50
26
14
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48a
57
50a

Fig. 4.

NOVEL EXTERNAL CIRCULATORY ASSIST DEVICE

BACKGROUND OF THE INVENTION

This invention relates to apparatus for assisting blood circulation by applying external pressure to the body. Such processes are generally known and are disclosed in, for example, U.S. Pat. No. 3,303,841 to Dennis and U.S. Pat. No. 3,654,919 to Birtwell.

As indicated in the Birtwell patent, the prior art devices usually achieved pressure by having liquid pressure cycled by a pump means attached to a liquid reservoir surrounding the legs of a patient being treated. More recently, apparatus has been developed whereby a mechanical platen rises and falls while in contact with a constrained leg-enclosing reservoir, thereby causing the pressure in the reservoir to cycle. This older apparatus is highly satisfactory in some circumstances but, as the therapeutic value of external assist apparatus becomes more apparent for various types of therapy, the known apparatus has been found to be heavier than is convenient for handling and portability.

SUMMARY OF THE INVENTION

Therefor it is an object of the invention to provide a lightweight limb-housing unit for use in external circulatory assist processes.

Another object of the invention is to provide a means to achieve the simultaneous and synchronous action of two leg units with a minimum of mechanical apparatus.

A further object of the invention is to utilize necessary superstructure of an external circulatory assist apparatus to serve the dual function of housing and pressurizing a liquid bladder.

Another object of the invention is to provide a pressurizing means having sufficient displacement capacity to provide suitable treatment for patients with a wide variety of limb sizes and without having to change water capacity of the pressurized, liquid-containing bladder wrapped about the limbs.

Other objects of the invention will be obvious to those skilled in the art on reading this application.

The above objects have been substantially achieved by using leg housing members as the means by which mechanical pressure is applied to liquid-filled blankets wrapped about the legs.

ILLUSTRATIVE EMBODIMENT OF THE INVENTION

In this application and accompanying drawings there is shown and described a preferred embodiment of the invention and suggested various alternatives and modifications thereof, but it is to be understood that these are not intended to be exhaustive and that other changes and modifications can be made within the scope of the invention. These suggestions are selected and included for purposes of illustration in order that others skilled in the art will more fully understand the invention and the principles thereof and will be able to modify it in a variety of forms, each as may be best suited in the condition of a particular case.

IN THE DRAWINGS

FIG. 1 is a view of a patient positioned for treatment in the apparatus of the invention.

FIG. 2 is a view similar to FIG. 1 excepting the apparatus is shown in an "open" position, i.e., a position wherein a relatively low pressure or no pressure is exerted by the housing apparatus on the legs of the patient.

FIG. 3 is an elevation of the actuating mechanism with the housing in the FIG. 1 position.

FIG. 4 is an elevation of the actuating mechanism with the housing in the open, i.e., the FIG. 2, position.

Referring to FIG. 1, it is seen that a patient is placed with his legs, from upper thigh to ankles, in an external pressure circulatory assist apparatus **10**. Apparatus **10** is placed on a table **12** and comprises a base plate **14** on which is mounted leg housing **16** comprising two leg-holding chambers **18**. Each chamber **18** consists of an upper shell **20** and a lower shell **22**. Lower shells **22** are fixed to base plate **14**. Upper shells **20**, however, are pivotally mounted onto the outer sides of shells **22** by quick-connecting fastening means **24**. The upper shell and lower shell are approximately coextensive with the legs of the patient.

FIGS. **3** and **4** show the means by which the pivotally-mounted shells **20** are moved.

Upper shells **20** are attached to generally triangular plates **26** which extend inwardly from the patient's limbs. Triangular plates **26**, when in the downward position shown in FIG. **3**, act as lever means for applying pressure to bladders **28** which encircle the legs of the patient. Plates **26** are integral with upper shells **20** and, as a consequence, pivot on the pin members **30** of quick-connecting fastening means **32**. Pin members **30** are mounted on brackets **34** and fastened to lower shells **22**. The pins extend laterally into receptacles in brackets **36** which are mounted on upper shells **20**.

Lower shells **22** are rigidly positioned on base plate **12** and connected to one another by lower bracing plates **38** which extend between the two lower shells.

Referring to FIGS. **4** and **5**, it is seen that base plate **14** carries mechanical actuator means **40** operably connected to pivot plates **26** upwardly and downwardly in response to the action of a hydraulic cylinder **42**. Hydraulic cylinder **42** is mounted on base plate **14** by means of mounting bracket **44**. A piston **46** is connected to the cylinder, thence to two bell-cranks **48** and **48***a*, mounted on brackets **50** and **50***a* respectively, through operating rods **52** and **54**. When the bellcranks are rotated clockwise by a leftward movement of piston **46**, they cause the downward movement of lift rods **57** and, consequently, the downward movement of plates **26** until they assume the position illustrated in FIGS. **1** and **3**. Conversely, when bellcranks **48** and **48***a* are rotated clockwise by a rightward movement of piston **46**, they cause the simultaneous upward movement of lift rods **57** and the upward movement of plates **26** to assume the position illustrated in FIGS. **2** and **4**.

Lift rods **57** are connected to lift assemblies **56**. Each lift assembly comprises a removable locking pin **58** which connects two pivot blocks **62**. Each pivot block **62** is connected to a pivot block retainer **64** by a pivot block shaft **66**. Pivot block retainer members **64** are attached directly to plates **26**. In operation of lift assembly **56**, it will be seen that lift rods **57** are pushed upwardly to bear against locking pins **58** and cause the lifting of pivot blocks **62**. Simultaneously shafts **66** rise, and allow the pivoting of, pivot block retainers **64** which are directly connected to plates **26**. This movement is reversed on the downward movement of the lift rods and an alternating pressure action is achieved by the device. In this action the generally hoop-shaped leg

compartments tend to withstand and dissipate stresses with substantially no change in their shape. This allows a more predictable control of the pressurizing cycle. Moreover, the vertical thrust necessary to operate the opening and closing of the leg compartments is largely dissipated through horizontal force vectors exerted on brackets **44** and **50***a*. Thus this force is largely counterbalanced by the tensile strength of base plate **14** and this factor contributes substantially to the dimensional stability of the apparatus in opposing vertical distortion during operation.

The liquid containing bladders, as is known in the art, are formed of a non-distensible material and fastened to the leg unit shell members to minimize any lateral movement of the bladders along the leg.

It is also to be understood that the following claims are intended to cover all of the generic and specific features of the invention herein described and all statements of the scope of the invention which might be said to fall therebetween.

What is claimed is:

1. In an external circulatory assist apparatus comprising a liquid-containing bladder means adapted to be positioned around a patient's limbs within a limb housing, the improvement wherein said housing comprises two limb-holding chambers, each said chamber comprising an upper shell portion and a lower shell portion and each said chamber adapted to be approximately coextensive with the limb enclosed therein, means for alternately moving said upper shells with respect to said lower shells to simultaneously increase and decrease the pressure exerted on said liquid containing bladder means in each chamber.

2. Apparatus as defined in claim **1** wherein said upper shells and lower shells are hinged together along the outer edges thereof, wherein said lower shells are stationary and each said upper shell is attached to a mechanical lift means to alternately push and pull said upper shells into compressing and decompressing relationship to said bladder means.

3. Apparatus as defined in claim **2** wherein said mechanical means comprises a hydraulic piston adapted to drive two spaced, vertically reciprocating lift rods into contact with said mechanical means, said lift rods being driven by driving means so mounted as to dissipate the opposing forces thereof as tensile forces normal to the direction of lift and along a base plate on which said mechanical means is mounted.

4. Apparatus as defined in claim **1** wherein said bladder means is fully enclosed and comprises no operable connection with an exterior source of liquid.

5. Apparatus as defined in claim **2** wherein said bladder means is fully enclosed and comprises no operable connection with an exterior source of liquid.

6. Apparatus as defined in claim **3** wherein said bladder means is fully enclosed and comprises no operable connection with an exterior source of liquid.

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